REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
17-05-2004	Final Report	July 2003 to July 2004

4. TITLE AND SUBTITLE
Pharmaceutical Logistics at the 121st General Hospital, Seoul, Korea

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

121st General Hospital
Unit # 15244
APO AP 96205
Seoul, Korea

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
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10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
35-04

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT The United States Forces Korea has continued to deter North Korean aggression and the 121st General Hospital (121st GH) has provided health care support during this period. The 121st GH pharmacy is an integral piece in the provision of health care in Korea. The purpose of the study is to determine the indicators of effective pharmacy support and determine if our current pharmaceutical logistics practice is efficient. The study reports an innovative application of multivariate approaches to predict order ship time (OST). The sample consists of 122 days of pharmaceutical requisitions. Pharmaceutical logistics data are used to estimate a multiple regression model of OST for demand satisfaction and accommodation, requisition cost and volume and source of supply. Multivariate correlations among five independent variables and the dependent variable, OST, are calculated. The average OST is 6.99 days. Demand satisfaction, requisition volume and source of supply measures make statistically significant contributions to the shared variance in overall OST, and yield an R^2 of .225 ($F_{(5, 116)} = 6.72$; $p < .0001$). The study's results, its usefulness for enhancing leadership's ability to evaluate pharmaceutical logistics, and its implications for current systems are discussed. By improving pharmaceutical logistics, the 121st General Hospital may deliver better health care on the Korean peninsula.

15. SUBJECT TERMS
Pharmaceutical Logistics System, Prime Vendor

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Education Technician
U	U	U	UU	53	19b. TELEPHONE NUMBER *(include area code)* (210) 221-6443

Running head: PHARMACEUTICAL LOGISTICS

Pharmaceutical Logistics at the 121st General Hospital, Seoul, Korea

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A Graduate Management Project submitted in partial fulfillment of the requirements for the degree of Masters in Health Administration

April 2004

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Acknowledgements

During my residency year, the 121st General Hospital has experienced a dynamic year with the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) survey and its continuing renovation project. Notwithstanding the numerous challenges, there were many individuals who provided guidance and support to ensure that my Graduate Management Project was a useful tool for the Military Health System.

I would like to thank my preceptor, LTC Mary E. Garr, Deputy Commander for Administration, who provided an awesome learning environment. LTC Garr allowed me the time and resources that I required to learn during my rotations and complete this project. Her guidance and professionalism demonstrated her excellence as a health care executive and her undying dedication to the U.S. Army-Baylor University Graduate Program in Health Care Administration.

I thank COL Roger Olsen, Chief of Logistics, Madigan Army Medical Center; LTC Jeffrey Unger, Commanding Officer, 16th Medical Logistics Battalion; and LTC Marilou Overla, Deputy Chief of Staff, Logistics, 18th Medical Command for their time, guidance, and logistical expertise that assisted me in accomplishing this project. They provided the logistical insight in the planning and development phase of the project.

I would also like to thank LTC Octavio Mont, Pharmacy Consultant, 18th Medical Command and MAJ Todd Williams, Chief of Pharmacy, 121st General Hospital for their direction and assistance in this project. They provided me with their pharmaceutical expertise that greatly assisted in the conduct of this project.

A very special thanks goes to CPT Michael Ball, Accountable Officer, 16th Medical Logistics Battalion; Mr. Chae-hui Yi, Systems Analyst, 16th Medical Logistics Battalion; SGT Clayton Anderson, Non-Commissioned Officer In Charge, Pharmacy Supply and Support Section, 121st General Hospital, and Mr. Kyu Man Pak, Pharmacy Technician, 121st General Hospital. These gentlemen provided all of the data for this project. This project could not have been accomplished without their assistance.

I am very grateful to Mr. Won Chin Kim, Medical Librarian, 121st General Hospital for his assistance to me while I conducted my research literature review. His expedient acquisition of

research documents was outstanding. He is truly one of the U.S. Army Medical Department's best.

A special thanks goes to MAJ Alan Ueoka, who was my sponsor to the 121st General Hospital. Alan served as a sounding board to many of my ideas and concerns during the conduct of this project. I appreciated his sound insight, judgment, and encouragement.

Also, I would like to thank my Mom, Mrs. Margery F. Giraud, for always supporting me in my endeavors. She also assisted me greatly during the didactic year, especially after my wife, Kelly, deployed to Iraq as a part of OPERATION IRAQI FREEDOM (OIF). My Mom has always been there for me when I needed her and I am most grateful.

My final and most noteworthy acknowledgement goes to my wife, Kelly H. Giraud. First, I thank her for her service to our nation especially during combat operations during OIF. Secondly, I thank Kelly for her never-ending support, encouragement, and love, which serve as my biggest inspiration.

Abstract

The United States Forces Korea has continued to deter North Korean aggression and the 121st General Hospital (121st GH) has provided health care support during this period. The 121st GH pharmacy is an integral piece in the provision of health care in Korea. The purpose of the study is to determine the indicators of effective pharmacy support and determine if our current pharmaceutical logistics practice is efficient. The study reports an innovative application of multivariate approaches to predict order ship time (OST). The sample consists of 122 days of pharmaceutical requisitions. Pharmaceutical logistics data are used to estimate a multiple regression model of OST for demand satisfaction and accommodation, requisition cost and volume and source of supply. Multivariate correlations among five independent variables and the dependent variable, OST, are calculated. The average OST is 6.99 days. Demand satisfaction, requisition volume and source of supply measures make statistically significant contributions to the shared variance in overall OST, and yield an R^2 of .225 ($F_{(5, 116)} = 6.72$; $p < .0001$). The study's results, its usefulness for enhancing leadership's ability to evaluate pharmaceutical logistics, and its implications for current systems are discussed. By improving pharmaceutical logistics, the 121st General Hospital may deliver better health care on the Korean peninsula.

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Pharmaceutical Logistics at the 121st General Hospital, Seoul, Korea

Introduction

The United States Army 121st General Hospital (121st GH) located in Seoul, Korea provides the United States Forces Korea (USFK) with level III health care support. Level III is the first level of care with hospital facilities. The 121st GH, as a level III facility, provides resuscitation, initial wound surgery, and postoperative treatment. The 121st GH provides health care to beneficiaries who include: U.S. military service members, retirees, U.S. Embassy personnel, Department of Defense (DoD) civilians, contractors, and all beneficiaries' family members. The 121st GH is the largest health care organization in the 18th Medical Command (18th MEDCOM) Integrated Health Organization (IHO). The mission of the 121st GH is "to provide integrated and comprehensive theater hospital support to include emergency care, disease management, surgical support and inpatient services across a full spectrum of operations" (18th MEDCOM Intranet, 2003).

Conditions that prompted the study

At the beginning of fiscal year 2002 (FY02), the 121st General Hospital Department of Pharmacy was established as a direct customer of the 16th Medical Logistics Battalion (16th MEDLOG) as the primary source for pharmaceutical materiel. On 1

July 2002, this was formalized as 18th MEDCOM Policy Memorandum Number 22, establishment of the 16th MEDLOG as the primary source of supply for medical materiel (18th MEDCOM, 2002, July 1) (Appendix A). Prior to this decision and policy, the 121st GH ordered its pharmaceuticals from the prime vendor (PV), AmerisourceBergen, which is located in Hawaii.

According to the policy (2002, July 1, p. 2), the 16th MEDLOG would "establish the 121st GH pharmacy as a direct customer and receive and issue requested material; stock pharmaceutical material that incurs six requests within a 12 month period; utilize the Defense Logistics Agency (DLA) Prime Vendor Contracts as the primary source for pharmaceuticals; utilize PV reach back procedures for the 121st GH pharmacy, which would enable PV materiel to be directly delivered to the requesting facility; substitute materiel in kind using PV equivalents unless explicitly requested by the pharmacy not to substitute; effect standardization of materiel when duplicate items are identified; and provide local purchase support to 18th MEDCOM units as necessary". The 18th MEDCOM also directed the 121st GH pharmacy to establish an account with 16th MEDLOG and to order all routine pharmaceuticals from them using Prime Vendor reach back procedures once the 16th MEDLOG order ship time (OST) averaged 5.5 days. These procedures were established with the intent to improve readiness, reduce risk associated with

transition to hostilities, and facilitate maximum availability of medical materiel for USFK and deploying units. However, the 121st GH pharmacy questioned whether readiness and maximum availability of pharmaceutical materiel has really improved.

According to Major Todd Williams (personal communication, September 12, 2003), Chief of Pharmacy, 121st GH, the delivery of pharmaceuticals in a timely manner is declining when ordering through the 16th MEDLOG. In a personal communication, MAJ Williams stated that the OST from 16th MEDLOG was approximately two weeks as opposed to the three-day OST direct from AmerisourceBergen. This could result in increased customer wait time if a pharmaceutical is not available, due to the extended OST, when the patient or ward makes the request. In a personal communication with Captain Michael Ball (November 6, 2003), Accountable Officer, 16th MEDLOG, the Theater Army Medical Materiel Information System (TAMMIS), the Army's Standard Army Management Information System (STAMIS) for medical logistics, indicates that the average OST for pharmaceuticals to 16th MEDLOG from the PV is 12.8 days. CPT Ball stated that the use of the PV reach back program was the exception and not the rule. This results in the majority of pharmaceuticals arriving at Korea's Incheon Airport, which is outside of Seoul, where they are transported to Camp Carroll in Waegwan, Korea, which is a four to five hour trip south of Seoul (Appendix B). Once the

pharmaceuticals arrive at the 16th MEDLOG warehouse, the warehouse soldiers processes them for receipt and issues them to the customer, including a return trip to Seoul, thus increasing OST to the 121st GH pharmacy. According to MAJ Williams, OST is not the only issue with ordering from the 16th MEDLOG.

The 121st GH pharmacy also experiences increased problems with substitutions of pharmaceuticals with other products, sizes, or inappropriate products. The 16th MEDLOG pharmaceutical item manager handles the reports of discrepancy. Overall, the 121st GH pharmacy has lost some autonomy in ordering pharmaceuticals that they enjoyed prior to FY02. According to Colonel Roger Olsen (personal communication, November 6, 2003), former 18th MEDCOM Deputy Chief of Staff, Logistics, the decision at the beginning of FY02 to order medical materiel through the 16th MEDLOG was based on operational and readiness concerns raised by the previous, Assistant Chief of Staff for Logistics for the United Nations Command, the Combined Forces Command, and USFK, Brigadier General Claude Christianson. BG Christianson directed 18th MEDCOM to stock 30 days of supply (DOS) of medical materiel to include pharmaceuticals (R. Olsen, personal communication). The medical materiel that the 16th MEDLOG stocks would have to be demand supported by what was being ordered by the customers and patients of the 18th MEDCOM. To build a demand supported medical materiel (Class VIII) authorized stockage list

(ASL), 16th MEDLOG must use automated historical data to ensure that they stock the necessary Class VIII. The primary consideration for authorizing addition, retention, and deletion of items from the ASL is the demand criteria. Assuming that demand does not change significantly during the initial stages, this process engenders less risk if USFK transitioned to hostilities with North Korea. In hostilities, the 16th MEDLOG would have to provide medical materiel to USFK military units and noncombatants attempting to evacuate from the Korean peninsula. In order to accomplish this mission, the 16th MEDLOG soldiers must be proficient with the associated tasks.

According to Lieutenant Colonel Jeffrey Unger (personal communication, November 6, 2003), Commanding Officer, 16th MEDLOG, the current system of ordering medical materiel allows 16th MEDLOG soldiers to practice the occupational skills they would be performing during hostilities. Therefore, the soldiers become proficient in their individual and collective tasks, the unit becomes more proficient in training to the Mission Essential Task List standard, and readiness is increased. This system also allows 16th MEDLOG to meet the challenge to "train the way we fight" (U.S. Army, 2003, p. 1-2). At the heart of this problem is the conflict between utilizing better business practices versus maintaining readiness to support major combat operations.

Statement of the problem or question

The problem is to ascertain in what ways can we improve pharmaceutical logistics efficiency by reducing customer wait time and pharmaceutical item order ship time, through utilizing better business practices, yet maintaining our focus on wartime readiness and accomplishing our principal goals of being a medical facility in providing quality health care in both armistice and during a transition to hostilities. By obtaining data on how the pharmaceutical logistics system is functioning on a daily basis at the 121st GH, the 121st GH and 18th MEDCOM leadership can gauge the current effectiveness of its logistics system against the PV system. By providing reliable and timely information on the daily requisitions and receipts at the 121st GH pharmacy, 121st GH and 18th MEDCOM decision makers can refine existing programs and focus guidance on logistics opportunities to improve pharmaceutical logistics and ultimately patient care.

Literature Review

Previous research revealed the types of business practices utilized by pharmacies in order to be more cost efficient and effective. Also, research in both military fixed facilities and medical field units has been conducted. These studies suggest predictors for efficiency and effectiveness and they are analyzed in this study.

Health care costs continue to increase in our Military

Health System. One contributor to rising health care costs is pharmaceuticals (Congressional Budget Office, 2003). According to Eckel and McAllister (1981), improving purchasing and management functions can reduce pharmaceutical costs. Eckel and McAllister believe that pharmacy managers can anticipate continued pressures to maintain or reduce supply costs through improved purchasing and management practices. "The consolidation of all pharmaceutical purchasing to the department as a means to promote efficient, consistent, and cost effective purchasing; the use of generic nomenclature as a means to promote vendor competition and minimize duplication of competitive brands; and the maintenance of a formulary of pharmaceutical products to minimize inventory carrying costs and unnecessary duplication" (Eckel and McAllister, 1981, pp. 45-46) are business practices which help pharmacy departments combat rising costs. The PV system is one way for pharmacies to attempt to reduce costs and improve their purchasing and management practices.

A PV relationship is defined as, "a commitment by a hospital pharmacy to purchase the majority of its drugs from a single source, usually a local wholesaler" (May and Herrick, 1984, p. 1375). May and Herrick (1984) suggest that PV relationships offer some potential advantages to pharmacists in terms of cost and efficiency. However, the applicability of this system must be carefully analyzed in each individual setting.

May and Herrick maintain that "lowering acquisition price, maintaining optimal quality, maximizing necessary vendor services, decreasing turnaround time, and minimizing inventory on hand" (p. 1373) are the goals of pharmaceutical purchasing systems. May and Herrick believe that many pharmacies turn to PV relationships because they are purchasing more and manufacturing less, do not possess the ability to handle increasing inventories, and have an inability to effectively interact with numerous vendor representatives. The advantage of the PV approach is decreasing overall costs associated with purchasing and inventory control. Other advantages may include decreased drug acquisition costs, decreased negotiated wholesaler fee, hospital inventory reduction, paperless ordering, and receiving valuable management reports from the wholesaler (May and Herrick). Pharmacy managers must be aware of the advantages and disadvantages of the procurement alternatives for their institutions. The utilization of prime vendors has both detractors and supporters.

Some critics believe that PV may not necessarily be the panacea of the health care industry. Prime vendor relationships require considerable effort to keep both the supplier and hospital committed to the same goals. If commitment, cooperation, and monitoring do not occur, then the attainable benefits of reduced costs, improved competition, attainable

sales, and profit increases will not be achieved (Bartlett, 1980). According to Bartlett, the PV contract is for a specified time and requests made after that time lapses, are not guaranteed for the supplier. Therefore, if the supplier fails to meet his or her terms of the contract, then the pharmacy can negotiate a new contract with a new vendor. Bartlett also suggests that the PV concept may assist to reduce costs, increase productivity, and improve customer relations. However, Bartlett maintains that suppliers need to serve the customer in the way the customer desires. Only in this way, will the patient benefit by a reduction in his or her health care costs. An analytical approach is necessary for successful PV contract negotiation.

According to Poncar (1984), a well negotiated PV relationship will allow increased internal cooperation between the pharmacy and the accounts payable department, increase efficiency in receiving materiel, and allow problem solving to occur more quickly since the PV is the only agency the pharmacy will need to contact. If controls are present, an excellent partnership can exist between the hospital and the vendor. Pitts (1984) believes the future is bright for the PV relationship and both the hospital and the vendor need to work smartly to keep the system functioning well. Housley maintains that "the supply priority profile, the mode of purchase order transmission, price

protection, a penalty clause, delivery time and frequency, business motivation percentage, price guidelines, purchase options, additional price protection for each year, management reports, and length of contract" (1980, p. 89) should be included in the negotiations between hospitals and potential prime vendors. According to Housley, if a hospital is committed to the PV concept, the total dollar volume of purchasing can be reduced by a "minimum of 10 percent" (p. 94). According to Young (1984, p. 12), "the term of the contract, the best quantity price, a negotiated percentage of the best quantity price, a penalty clause, and the motivation percentage" are five important basic elements of negotiating a PV contract. Commitment, skillful contract negotiation, and communication are critical to the success of a PV relationship. Some military and governmental agencies incorporate PV relationships into their business practice.

U.S. Naval Hospital, Sigonella faced a business decision to either use a PV or the federal supply system for pharmaceuticals soon after it opened its doors on 23 January 1993. According to Koerner and Anaya (1996), the single most important factor affecting the success or failure of health care support was reliable transportation. Sigonella Naval Air Station lies over "400 miles from its nearest Naval hospital counterpart in Naples, Italy; 1,100 miles from the United States Army Medical

Materials Command Europe (USAMMCE) in Pirmasens, Germany; and 1,200 miles from the Naval Hospital in Rota, Spain" (Koerner and Anaya, 1996, p. 607). This isolation from other facilities is an obstacle. According to Koerner and Anaya, inventory control under the federal supply system is difficult due to the staff ordering months' worth of supplies due to an unresponsive system. Use of a prime vendor system was investigated and implemented on 17 July 1995. Sigonella tracks its performance by, "turn around time (total number of days), turn around time (consistency), order confirmation by hard copy, real time on-screen ordering information, electronic order transmission capability, fair returns goods policy, adherence to a dating policy, superior fill rates, performance reports availability, emergency system availability, shipment tracing after carrier pick up, positive online customer support, segregation of the pharmacy ordering practices from the medical logistics department, waste reduction, inventory reduction, diminished man hours, and diminished not-in-stock percentages" (Koerner and Anaya, 1996, p. 610). Sigonella achieved success with its PV program and they effectively managed their inventory.

The Department of Veterans Affairs (VA) was also concerned with large stockpiles of pharmaceuticals and began a pilot test of a PV system in 1991. In January of 1992, the vendors serving the test hospitals implemented the new PV procurement system.

The VA system procedures are, "the pharmacy decides to order stock on a computerized comparative database; the pharmacy electronically places the order; within two hours of ordering, a status is received from the PV; the order is received by the pharmacy; and the packing list serves as the invoice and is certified for payment by the receiving official" (Patterson, Pierce, and Powell, 1995, p. 1887). According to Patterson, Pierce, and Powell, the benefits of the new system are reduced costs, quicker turn around time for orders, higher fill rates, and increased satisfaction among users. The results in the VA are improved system responsiveness, increased satisfaction of system users, and reduced expenses. Prime vendor continues to be successful in providing substantial savings to federal fixed facilities.

In 1994, the 62d Medical Group and Madigan Army Medical Center (MAMC) conducted a feasibility study of PV support for the 18th Mobile Army Surgical Hospital (MASH), a medical field rapidly deployable unit. This study found numerous issues with the field sets, kits and outfits (SKO). First, the field medication lists were developed in the 1960s and did not contain medications considered current first line of therapy (Rembold and Berry, 1997). Medication lessons learned from Operations Desert Shield/Desert Storm were not integrated into the development of the field SKOs. Medical field units spend a large

part of their budget annually on rotating expired medications. The 18th MASH estimated that the cost to their unit was "$30,000 to $50,000 for replacement of all 6,505 items" (Rembold and Berry, p. 68). Rembold and Berry proposed that PV is a way to rapidly adjust formularies to endemic requirements, reduce the losses incurred by expiration of medications, reduce storage facilities, and eliminate specific supply quality control requirements. Rembold and Berry also found that the one advantage of having a PV relationship would be a decrease of the period of time it takes to attain a greater than 95 percent fill of pharmaceutical stock. The results of this trial demonstrated strong support for PV utilization to support medical field units and future deployments. However, deployed units are another challenge.

Operation Iraqi Freedom has required transformational changes in the Army's medical logistics systems. Today, the medical footprint on the battlefield is smaller as a result of the Army Medical Department Re-engineering Initiative. The employment of 20 person forward surgical teams in lieu of MASH units and 88-bed Combat Support Hospital (CSH) modules in lieu of the 296-bed base CSH are examples (Brew and Baker, 2003). These smaller units require more flexible and timely supply packages and medical logisticians have to adapt to this change. Improvements in medical logistics automation through TAMMIS and

TAMMIS Customer Assistance Module (TCAM) are essential to more efficient supply-chain management (Brew and Baker). According to Brew and Baker, significant business changes and integration with the Defense Supply Center Philadelphia (DSCP) Prime Vendor Program have resulted in the iron mountain of medical materiel to disappear. Doctrinal changes result in medical logistics cooperation among the armed forces and the concept of the single integrated medical logistics manager (SIMLM) is evolving (Brew and Baker). Prior to SIMLM, each branch of the armed forces planned and coordinated medical logistics independently. Currently, the SIMLM concept allows the combatant commander to appoint a single manager to oversee supplies. The readiness of the medical force and logistically supporting the force are accomplished through partnering with the commercial sector (Brew and Baker). However, medical logistics challenges have been present in OIF.

The perception from supported units and clinicians in the field is that medical logistics is broken because the "MEDLOG units arrived too late; inadequate planning processes; no process to identify individual requirements for prescription medications; distribution capabilities did not meet customer requirements; medical units possess inadequate automation; poor medical logistics leaders training and education; and metrics are not available to monitor performance" (Office of The Surgeon

General, p 10). According to the USCENTCOM Surgeon (2003), the SIMLM was difficult to establish due to lack of automation systems among the services to communicate with each other. Although, one military service serves as the executive agent, medical logistics did not occur as a true joint operation. According to Olsen (2003), pharmaceuticals, specifically management medication, are a difficult issue to tackle for medical logisticians. Many service members ran out of their medications while deployed to OIF. According to the Office of The Surgeon General, there is not a process to identify prescription requirements in the soldier readiness program prior to deployment. This issue crosses all boundaries including all branches of the Armed Forces, contractors, and Department of Defense (DoD) civilians. Military medical sets, kits, and outfits do not contain chronic medications and therefore the theater has had no visibility of requirements. OTSG recommends that, "units must capture requirements at mobilization or home station; medical elements need to assess deployability of individuals with chronic conditions; medical staffs need to provide visibility to unit surgeon and theater MEDLOG; a national database needs to be created to capture theater requirements; CONUS capabilities must be leveraged to dispense and push refills; and deployed units must provide a minimum of 180 days worth of maintenance medication" (p. 17). The keys to

success are prior planning to obtain visibility of chronic medication requirements before deployment and a clear strategy for prescription refill for deployed service members.

Purpose

The purpose of this study is to determine the indicators of effective pharmacy support and whether our current practice of ordering pharmaceuticals is efficient and effective in providing pharmacy support. The objectives of this study are to analyze the pharmacy's current procedures of ordering pharmaceuticals, analyze the 16th MEDLOG current pharmaceutical logistics system, analyze the PV system of pharmaceutical logistics, review published Army logistics regulations and literature, review civilian literature on pharmaceutical logistics, conduct a regression analysis to build a statistical model for effective pharmaceutical logistics, and relate the significant indicators of pharmaceutical logistical effectiveness to the staff of the 121st GH and 18th MEDCOM. There are two working alternate and null hypotheses. The first alternate hypothesis is that differences in order ship time, demand satisfaction, demand accommodation, source of supply, item cost, and volume are related to the differences in customer wait time. The second is that demand satisfaction, demand accommodation, source of supply, item cost, and volume are related to the differences in order ship time. The first working null hypothesis is that differences in

customer wait time are not influenced by differences in order ship time, demand satisfaction, demand accommodation, source of supply, item cost, and volume. The second is that differences in order ship time are not influenced by differences in demand satisfaction, demand accommodation, source of supply, item cost, and volume.

Method and Procedures

Beings, objects & events

The data set consists of n=122 requisition days of the 121st GH pharmacy ordering pharmaceuticals from 16th MEDLOG and PV. This time period occurs from 1 December 2003 until 3 March 2004. The sample population of ordering days does not include holidays or weekends when ordering activity does not usually take place.

Sampling procedures and means of data gathering

The first dependent variable (Y_1) is the average daily customer wait time for a drug not in stock and requested by a patient or ward. The 121st GH pharmacy personnel tracks and keeps this data on a tracking log. The time is tracked from when the patient or ward requests a pharmaceutical until the patient or ward receives the prescription for a temporarily out of stock item. The first independent and second dependent variables (X_1 and Y_2) are the daily average order ship time in number of days for pharmaceuticals from the time they are ordered from the 121st GH until the pharmacy receives the actual product. This data was

pulled from TAMMIS at the 16th MEDLOG and the PV invoice. The second independent variable (X_2) is the daily average demand satisfaction for pharmaceuticals. This data came from the 16th MEDLOG TAMMIS and the PV invoice. Demand satisfaction shows the percentage of requests against stocked lines that are filled by 100 percent of the total quantity demanded. It involves not only stocking the right item, but also carrying sufficient quantities to fill an order. The third independent variable (X_3) is the daily average demand accommodation for pharmaceuticals per TAMMIS at the 16th MEDLOG and the PV invoice. Demand accommodation shows the supply activities' success at stocking the items customers are demanding and their ability to respond to changes in demand patterns. The fourth independent variable (X_4) is the daily average requisition cost in dollars for pharmaceuticals, which is provided by the TAMMIS document register and the PV online ordering document. The fifth (X_5) variable is the average daily volume of requisitions being ordered by the 121st GH Pharmacy. This variable was measured by the daily average number of requisitions from 16th MEDLOG and PV. The variable came from the TAMMIS document register and the PV online ordering document. The final (X_6) variable is the sources of supply for pharmaceutical requisitions, which is nominal data and coded 1 if a PV requisition and 0 otherwise. Operational definitions of the variables are shown in Appendix C.

Validity and reliability

The data in this study is both reliable and valid. TAMMIS, PV Internet ordering documents, and internal tracking and document registers are the sources of data collection. The TAMMIS and PV systems contain the following data elements: order ship time, demand satisfaction and accommodation, source of supply, and item cost. The 121st GH pharmacy documents and logs how long a customer waits for a temporarily "not in stock" item. The pharmacy tracks and reports this information every month at the 18th MEDCOM Review and Analysis (R&A). The U.S. Army and 18th MEDCOM use the monthly data as indicators for logistical efficiency and are considered reliable. The data collected for this study are from TAMMIS, which is the standard for the Army medical logistics community, and therefore, are considered valid.

Experimental design and data analysis techniques

Descriptive statistics and multivariate correlations are calculated between each of the independent variables and customer wait and order ship time. Alpha probabilities are set at the $p=.05$ level of analysis for all data sets. Techniques of multiple regression are used to test hypotheses that each independent variable in the model makes an individual contribution toward explaining variance in order ship and customer wait time above the variance it shares with the other

independent variables considered. The variables in the graphic model are placed into a Stepwise Multiple Linear Regression Analysis to determine the best model for predicting order ship and customer wait time.

Ethical Considerations

Personal Health Information (PHI) and logistical factors involving unit operational readiness are of concern in this study. All data have unique patient information removed to eliminate possible identification. Operational readiness cumulative information is not included in this study.

Expected Findings and Utility of Results

I expect to find significant predictors of order ship and customer wait time for pharmaceuticals. I anticipate that inefficiencies in our current pharmaceutical logistical system will be identified during this study. The results of this study will show the predictors for pharmaceutical efficiency, specifically order ship and customer wait time that the 121st GH administrators, logisticians, pharmacy personnel, and 16th MEDLOG personnel must consider. The results of this study will reflect the roles that the independent variables play in affecting order ship and customer wait time. This study will affect the way the 121st GH pharmacy and 16th MEDLOG conduct business and offer recommendations to improve the procedures that are currently in place. By improving pharmaceutical

logistics efficiency, the 121st GH pharmacy will provide better care to its patients and the Army a more ready and reliable force across the entire spectrum of operations from peace to combat.

Results

Two hypotheses are tested in this study. The first is that differences in order ship time, demand satisfaction, demand accommodation, sources of supply, item cost, and requisition volume are related to the differences in customer wait time. The second is that demand satisfaction, demand accommodation; sources of supply, item cost, and requisition volume are related to the differences in order ship time. The first hypothesis shows no relation for the independent variables to customer wait time. However, the second hypothesis is accepted due to statistical significance. Descriptive statistics that summarize relevant characteristics of order ship time are shown in Table 1.

Table 1
Descriptive Statistics for Full Model:

	Mean	Standard Deviation	n	r
Order Ship Time	6.99	5.58	122	1.00
Demand Satisfaction %	78.46	27.01	122	.207*
Demand Accommodation %	81.52	29.72	122	-.120
Requisition Cost $	544.13	852.59	122	.004
Volume of Requisitions	24.74	32.04	122	.319*
Source of Supply	.50	.50	122	-.364*

Note: N=122 observations; * $p < .05$

As shown, three independent variables are statistically significant predictors of order ship time. Demand satisfaction is a significant predictor of order ship time (r = .207, p < .05). The volume of requisitions is a significant predictor of order ship time (r = .319, p < .01). The third statistically significant predictor of order ship time is the source of supply of pharmaceuticals (r = -.364, p < .01). These significant variables provide a managerially useful basis for determining reasons that explain the wide variations within order ship time. These findings are clear evidence that differences among demand satisfaction, the volume of requisitions, and the source of supply have significant order ship time effects.

Also presented, are the prime vendor and 16th MEDLOG data, which are examined separately. When the sources of supply specific data are compared, distinct differences are found between the two sources. Descriptive statistics that summarize relevant characteristics of both the 16th MEDLOG pharmaceutical requisitions and those from PV are shown in Table 2. As shown in Table 2, PV average daily OST is less than the 16th MEDLOG's OST. Both PV's average daily demand satisfaction and accommodation are superior to 16th MEDLOG's demand satisfaction and accommodation. The average cost per requisition for PV is less than the 16th MEDLOG cost. However, the majority of

pharmaceuticals on an average daily basis are ordered through 16th MEDLOG in accordance with 18th MEDCOM policy (2002, July 1).

Table 2

Descriptive Statistics for Order Ship Time by: Source of Supply

	Mean	Standard Deviation	n
16th MEDLOG Requisitions			
Order Ship Time	9.02	7.31	61
Demand Satisfaction %	76.05	36.87	61
Demand Accommodation %	64.41	34.37	61
Requisition Cost $	632.89	1182.78	61
Volume of Requisitions	41.31	38.66	61
PV Requisitions			
Order Ship Time	4.97	1.03	61
Demand Satisfaction %	80.87	10.01	61
Demand Accommodation %	98.64	1.99	61
Requisition Cost $	455.36	225.72	61
Volume of Requisitions	8.16	4.15	61

Note: N=122 observations

Results of multivariate regression analysis, that evaluated the degree that the model of order ship time is appropriately specified, are presented in Table 3. As shown in Table 3, each of the independent variables, except demand accommodation and cost, accounts for a statistically significant amount of variance in order ship time. The full regression equation produces an R^2 of .225. As a group, these results explain 22.5 percent of the variance in order ship time in the sample, and provide an acceptable basis for estimating overall order ship time for pharmaceuticals, controlling for the effects of the

variables in the model. The uniquely explained variance is addressed in the discussion.

Table 3

Effects of Predictors for Order Ship Time

Effects Tested	R^2 Full Model	R^2 Reduced	R^2 Loss Unique	df_1	df_2	F	p
Full Model	.2245	0	.2245	5	116	6.72	.0000*
Demand Satisfaction	.2245	.1590	.0655	1	120	5.394	.0219*
Demand Accommodation	.2245	.2003	.0242	1	120	1.744	.1892
Requisition Cost	.2245	.2234	.0011	1	120	.002	.9614
Volume of Requisitions	.2245	.2027	.0218	1	120	13.632	.0003*
Source of Supply	.2245	.2198	.0047	1	120	18.343	.0000*

Note: * p< .05

Although no significant indicators are found for customer wait time, it is important to address the issue of the average days a customer is waiting to receive an item that is temporarily out of stock at the 121st GH pharmacy. During the period that data collection occurred, the average number of days that a patient, clinic, or ward had to wait for a pharmaceutical item that was temporarily out of stock in the pharmacy and on valid requisition is 46 days. In these cases, neither 16th MEDLOG nor AmerisourceBergen could meet the 121st GH Pharmacy's customers' requirements.

Discussion

This study seeks to identify predictors of order ship time and

customer wait time for pharmaceutical logistics at the 121st GH. There are no significant predictors found in respect to customer wait time. This study indicates that the variables of demand satisfaction, volume of requisitions, and the source of supply are significant predictors of order ship time for pharmaceutical supplies. Demand accommodation and cost are not predictors of order ship time for pharmaceuticals. This study is important because it develops a methodological approach to predicting order ship time that retained the benefits of multivariate analysis and provided leadership a useful basis for evaluation of pharmaceutical logistics. This study demonstrates demand satisfaction variation is in agreement with the studies of Koerner and Anaya (1996); Patterson, Pierce, and Powell (1995); and Poncar (1984). This study also supports source of supply variation as found in a study by Rembold and Berry (1997). This study expands the current body of knowledge by showing that daily volume of requisitions also serves as a predictor of order ship time and that the cost per requisition does not have a statistically significant impact on order ship time. The uniquely explained variance for the full model is shown in Figure 1.

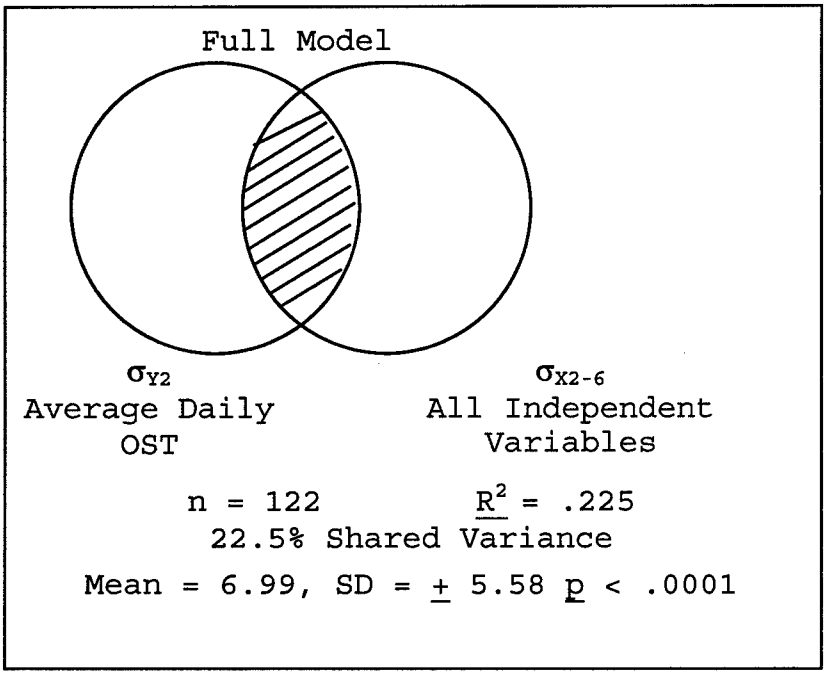


Figure 1. Venn diagram representing the testing effects on order ship time due to all independent variables: demand satisfaction, demand accommodation, requisition cost, requisition volume, and source of supply.

Demand satisfaction and order ship time

The data set for demand satisfaction and order ship time indicates positive correlations. Graphs of the regression line and uniquely explained variance for demand satisfaction are shown in Figure 2. A strong indication of the affect of the average daily demand satisfaction on order ship time is reflected by the angle of its slope. The graph infers that the higher the demand satisfaction or the ability for the supply activity to meet the quantity demanded for stocked lines, the

less order ship time will occur. This allows the pharmacy to receive its pharmaceutical requisitions in less time. The 16th MEDLOG average demand satisfaction during the study is 76 percent. The average demand satisfaction for PV is 81 percent. This infers that the PV, AmerisourceBergen, is able to meet the quantities of pharmaceuticals demanded more effectively than 16th MEDLOG. The Department of the Army management level for demand satisfaction is between 90 to 98 percent (U.S. Army, 1995, January 25). Neither 16th MEDLOG nor PV meets this goal for pharmaceuticals.

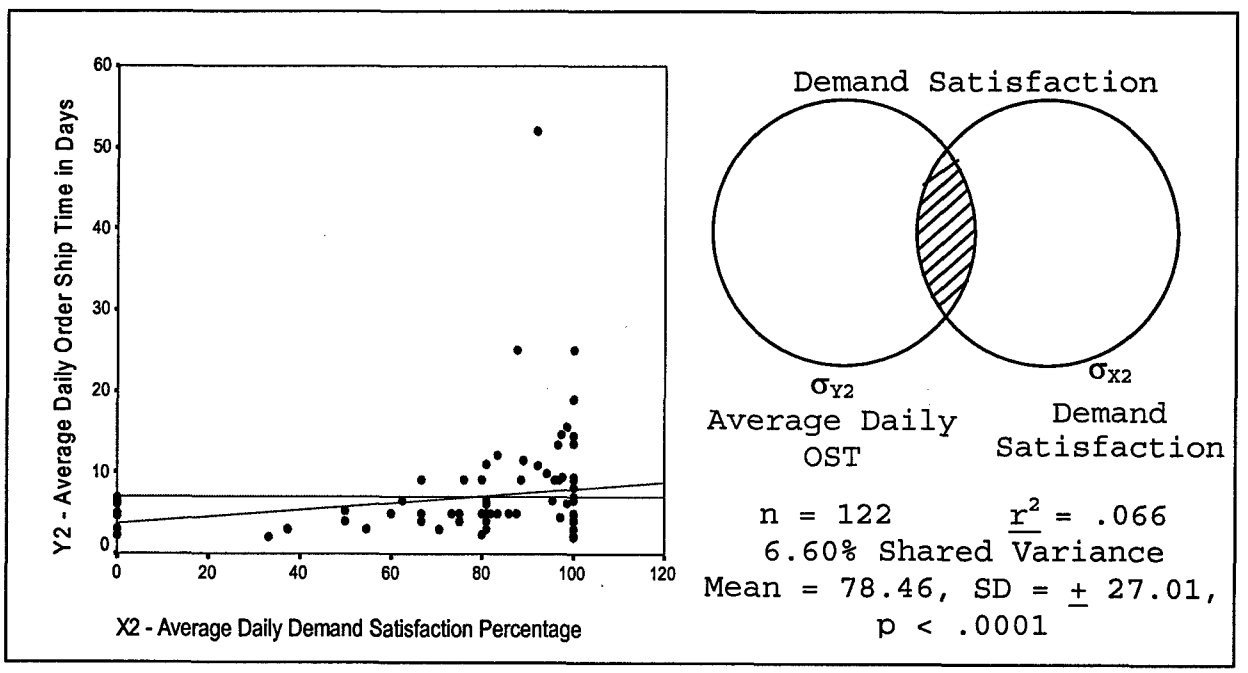


Figure 2. Scatter plot and Venn diagram representing the testing effects due to demand satisfaction.

Volume of requisitions and order ship time

The data set for the average daily volume of requisitions

and order ship time indicates positive correlations. Uniquely explained variance and a graph of the regression line for requisition volume are shown in Figure 3. There is also a strong indication of the affect of the average requisition volume on order ship time, which is reflected by the angle of its slope. The graph infers that the smaller the amount of volume of daily requisitions, the less order ship time will occur. The 16th MEDLOG daily average requisition volume during the study is 41 requisitions. The daily average requisition volume for PV is eight requisitions. This supports the greater average OST for 16th MEDLOG. As found in the study by May and Herrick (1984), PV appears to allow for more purchasing and inventory control which would preclude making large bulk purchases. Inventory control can be more efficient at both the 16th MEDLOG and 121st GH Pharmacy.

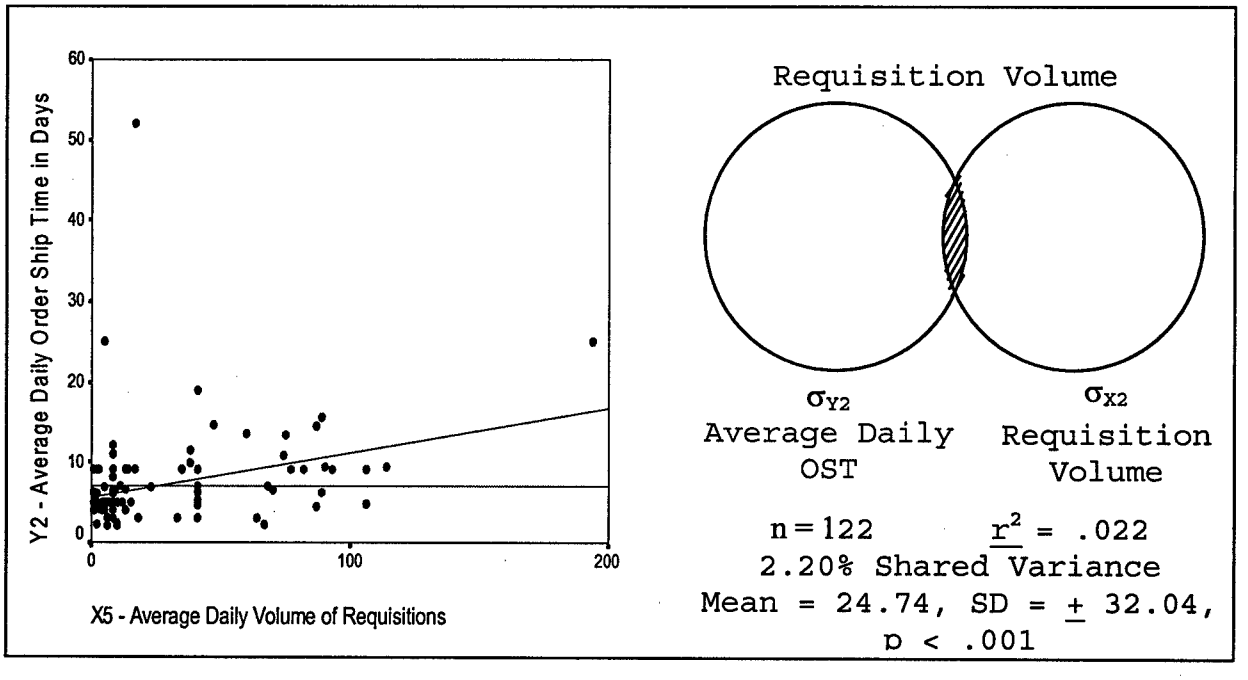


Figure 3. Scatter plot and Venn diagram representing the testing effects due to volume of requisitions.

Source of supply and order ship time

The data set for the source of supply for requisitions and order ship time indicates positive correlations. Figure 4 shows uniquely explained variance and a graph of the regression line for source of supply. There is a strong indication of the affect that source of supply has on order ship time which is reflected by the angle of its slope. The graph supports the descriptive statistics, which suggests that if the requisitions are ordered through the PV, then the OST is reduced. The longest daily average OST for the PV during the project is 11 days compared to 52 days for 16th MEDLOG. 16th MEDLOG needs to look at the PV system for efficiencies to reduce OST.

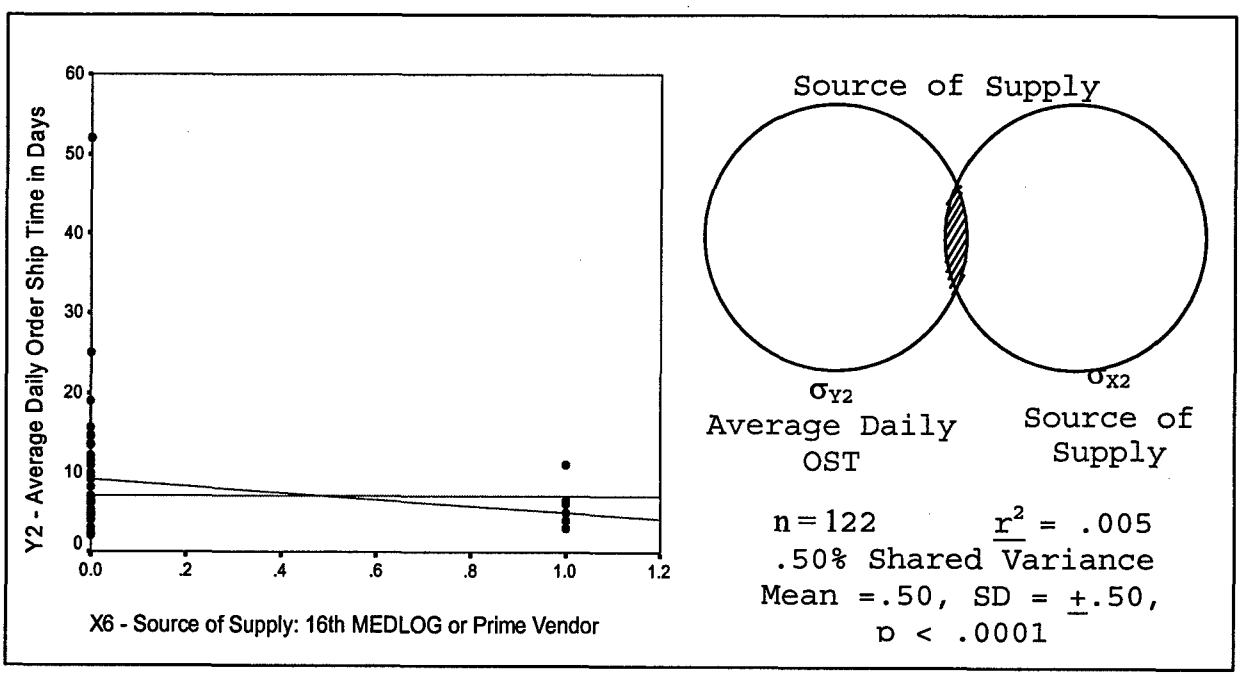


Figure 4. Scatter plot and Venn diagram representing the testing effects due to the source of supply, 16th MEDLOG or the PV, AmerisourceBergen.

Prime vendor reach back and order ship time

According to 18th MEDCOM policy (2002, July 1), once the order ship time for 16th MEDLOG stocked pharmaceuticals reaches 5.5 days, then PV reach back procedures are implemented. This procedure allows for items passed from 16th MEDLOG to PV to be shipped directly to the 121st GH and not the 16th MEDLOG supply support activity in Waegwan, Korea. Requisitions that are passed back to PV from 16th MEDLOG are e-mailed to item managers at AmerisourceBergen. 16th MEDLOG supply technicians are not able to access the PV online ordering system. The reach back program was initiated during the study. The PV reach back requisitions were counted as 16th MEDLOG requisitions.

In December, the average OST for PV reach back requisitions is five days. In January, the average PV reach back OST increased to 8.2 days. From 1 February to 3 March 2004, the PV reach back average OST progressively worsened and increased to 27.5 days. This reach back program contributed to an increased overall OST for items originally ordered through 16th MEDLOG. Policy Memorandum Number 22 (2002, July 1) does not address how the PV reach back system is supposed to function. The customer,

121st GH pharmacy, is unaware how the reach back system is to work and this study shows that the system did not improve pharmaceutical logistics during the period from 1 December 2003 to 3 March 2004.

Weaknesses of the study

The potential for methodological weaknesses exist in any study. Inventory cost and "not in stock" percentages are not looked at as possible predictors of customer wait time or order ship time. This is due to the lack of inventory stockage automation capability of the 121st GH pharmacy. Currently, there is no automated process to determine the zero balance percentage or the total cost of the pharmaceutical inventory on hand. Another area that is not investigated as a potential predictor of customer wait time or order ship time is pharmaceutical manufacturer limitations. There are instances where pharmaceuticals are on valid requisition, but patients, clinics, or wards are waiting on them, and where the manufacturer is temporarily out of stock. This causes the supply system to fail for all parties involved and serves as a confounding variable that cannot be controlled. Lastly, in respect to readiness, it is hard to put a cost on preparing for our mission to provide combat health support during war. Since the 121st GH is a medical field organization, it has a wartime mission that it must be prepared to accomplish. The price of readiness rests in the

blood, sweat, and tears of the soldiers on the training field.

Implications of the study

The findings of this study have implications for 18th MEDCOM and 121st GH doctrine concerning pharmaceutical logistics. As previously indicated, regulations and policies are outlined in 18th MEDCOM Policy Memorandum Number 22 (2002, July 1). However, policy alone is not a sufficient tool for commanders to ensure that pharmaceutical logistics efficiency exists, but merely ensures that the subordinate units are within regulatory guidance. The system standing operating procedures must be published and practiced by the supply activity and its customers to ensure efficient and effective pharmaceutical logistics. Leaders must ensure these standard procedures are enforced so that readiness on this fragile peninsula is maintained.

Conclusion and Recommendations

The decision to establish 16th MEDLOG as the SIMLM for the Korean theater of operations rests on readiness concerns in the event of a transition to hostilities with North Korea. Current lessons learned in OIF support the change in doctrine to the SIMLM concept (Brew and Baker, 2003). For readiness reasons we must practice in peace the way we will conduct business in war. In order for 16th MEDLOG to become a more efficient and effective SIMLM, pharmaceutical order ship time must be reduced.

Prime vendor reach back recommendations

To ensure a reduction in OST days, the PV reach back system must be utilized, but not in its current form. This will ensure that pharmaceutical items, which are passed from 16th MEDLOG to the PV, are delivered directly to the 121st GH pharmacy. The procedures must be understood by all parties involved to avoid shipment to the 16th MEDLOG warehouse in Waegwan. These reach back requisitions must be clearly identified to the PV by the pharmaceutical item managers at 16th MEDLOG. This will simplify the supply system for all involved.

Process automation recommendations

To further simplify the system, 16th MEDLOG needs to fully automate the PV reach back process. Currently, the supply technicians are e-mailing the PV technicians the reach back requisitions. When the e-mail is received at the PV, the PV technicians then enter the requests into their online requisition system. 16th MEDLOG needs to gain access to the PV online ordering system. This will enable the 16th MEDLOG to order pharmaceuticals on a computerized comparative database and within minutes of ordering, receive a status from the PV. The 16th MEDLOG can then pass on the most up to date status to the customer, rather than waiting on a PV technician to read his or

her e-mail. This should expedite the reach back process, thus potentially reducing OST.

Demand satisfaction recommendations

To further expedite the process, average demand satisfaction must increase for pharmaceuticals. Since the current pharmaceutical demand satisfaction is low, 16th MEDLOG must examine the zero balance rate, receipt processing time, and the validity of OST quantities based on recent experience. Demand satisfaction indicates the adequacy of reorder levels. This means 16th MEDLOG must investigate whether pharmaceutical stockage quantities are sufficient considering OST and fluctuating demands. To accomplish this, I recommend that 16th MEDLOG conduct annual ASL review boards with their customers as a part of the review team. This will ensure that the subject matter experts are present to add to the process. ASL reviews standardize the way for continuous logistics operations. By using automated historical data and the experience of the board members, participants on an ASL review board make sure that a SSA stocks the necessary items in the correct quantity and type. This process should also reduce substitutions of pharmaceuticals with other products, sizes, or inappropriate products and provide the customer with what they truly need. As a result, updating the lines of pharmaceuticals in stock may save money, reduce the order ship time, and enhance customer satisfaction.

Purchase and inventory control recommendations

By increasing demand satisfaction, 16th MEDLOG should enable its customers to practice purchasing and inventory control. 16th MEDLOG will stock the correct items in sufficient quantities, which will enable the 121st GH pharmacy to decrease its pharmaceutical inventory, thus reducing cost. This should reduce the large, less frequent, bulk orders that have occurred during this project's duration. This will allow the 121st GH pharmacy to control its purchases to a smaller volume of requisitions, thus enabling decreased order ship time. However, the 121st GH pharmacy must fully automate its pharmaceutical stock, both in the pharmacy and the supply and support warehouse. This will allow true purchasing and inventory control to take place and cost savings to be realized.

Source of supply recommendations

As stated above, 18th MEDCOM must be prepared to provide combat health support in the event of an escalation to hostilities. For this reason, I recommend that 18th MEDCOM Policy Memorandum Number 22 (2002, July 1) retain 16th MEDLOG as the SIMLM. However, I do recommend that in emergency situations and for special pharmaceutical requests that the 121st GH Pharmacy continue to order directly through the PV. 16th MEDLOG orders direct from PV for most of the pharmaceuticals on their ASL. 16th

MEDLOG must attempt to mirror the efficiencies that the PV system possesses to provide better order ship time, demand satisfaction, and purchase control.

Further research recommendations

I recommend further research. Once the 121st GH pharmaceutical inventory is fully automated, inventory costs can be looked at as a predictor of customer wait time and order ship time. Also, the 121st GH pharmaceutical inventory automation will allow "not in stock" or "zero balance" percentages to be looked at as a predictor. Manufacturer limitations should be addressed and their effects determined for customer wait time and order ship time. These recommendations will expand the current body of knowledge of pharmaceutical logistics.

Commitment and skillful communication are critical to the success of pharmaceutical logistics efficiency. Increasing pharmaceutical logistics efficiency and effectiveness by reducing order ship time will further allow the 121st GH to provide quality health care to its patients. The 121st GH will then remain prepared, "to provide integrated and comprehensive theater hospital support to include emergency care, disease management, surgical support and inpatient services across a full spectrum of operations" (18th MEDCOM Intranet, 2003).

Appendix A - 18th MEDCOM Policy Memorandum Number 22

DEPARTMENT OF THE ARMY
HEADQUARTERS, EIGHTEENTH MEDICAL COMMAND
UNIT #15281
APO AP 96205-0054

REPLY TO
ATTENTION OF:

EAMC-L-LO (40)

16 OCT 2002

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Policy Memorandum Number 22, Establishment of the 16th Medical Logistics Battalion as the Primary Source of Supply for Medical Materiel

1. Purpose. The purpose of this policy is to outline the procedures to support and establish the 16th Medical Logistics Battalion (MEDLOG) as the primary source of supply for pharmaceuticals and medical materiel for all units assigned or attached to the 18th Medical Command (MEDCOM). These procedures are designed to improve readiness, reduce risk associated with transition to hostilities, and facilitate maximum availability of medical materiel for USFK and deploying units.

2. Application. This policy is applicable to all military personnel and civilian employees involved with the acquisition or management of medical materiel in support of the 18th MEDCOM's patient care mission during armistice.

3. Execution. This policy is effective upon signature of the Commander, 18th MEDCOM. The action office for establishment and review of this policy is the DCSLOG, 18th MEDCOM.

4. Definitions.

a. Medical Materiel. Medical and dental supplies/equipment with a Materiel Category Structure Code of "C" are considered medical materiel. Examples of medical materiel includes: pharmaceuticals, surgical instruments, bandages, dental burs, x-ray film, and lab reagents.

b. Prime Vendor Reach-Back. A procedure and automation process that enables Prime Vendor materiel to be directly delivered to the requesting facility for medical materiel not available at the 16th MEDLOG.

5. Deployment.

a. General. Effective upon signature of this policy memorandum, routine government credit card and local purchase of pharmaceutical and medical materiel are only authorized by the 16th MEDLOG. The attending physician or the Chief, 121st General Hospital Pharmacy may grant approval for emergency procurement of medical materiel by organizations other than the 16th MEDLOG when materiel is not available at

Appendix A - 18th MEDCOM Policy Memorandum Number 22

EAMC-L-LO (40)
SUBJECT: Policy Memorandum Number 22, Establishment of the 16th Medical Battalion, Logistics as the Primary Source of Supply for Pharmaceutical Materiel

the 16th MEDLOG or when materiel arrival will not meet the documented urgent need. Emergency procurements will be documented and reported to the 16th MEDLOG within 15 days of the procurement.

b. Pharmaceuticals. During the course of fiscal year 2002, the 121st General Hospital (GH) Pharmacy will be established as a direct customer of the 16th MEDLOG and will use the 16th MEDLOG as the primary source of supply for pharmaceutical materiel that is stocked by the 16th MEDLOG. Once the order-ship-time (OST), date of receipt minus date of request, for 16th MEDLOG stocked items, averages 5.5 days for the 121st GH Pharmacy, the 121st GH Pharmacy will use Prime Vendor Reach-Back procedures. In effect the 121st GH Pharmacy will use the 16th MEDLOG for all routine pharmaceutical requests. OST for the 121st GH Pharmacy will be determined using the receipt and request dates from the 121 Hospital Pharmacy's Defense Medical Logistics Standard Support (DMLSS) system. Additionally, radio frequency (RF) tags may be used to verify pharmaceutical delivery dates from the 16th MEDLOG to the 121st GH Pharmacy.

c. Systems. 18th MEDCOM units shall only use Department of the Army approved logistics systems such as TAMMIS, DMLSS, and TCAM or may use manual methods as described in AR 710-2 series to manage medical materiel.

6. Responsibilities.

a. The 18th MEDCOM DCSLOG:

(1) Will monitor the implementation and development of this project.

(2) Will audit progress on a monthly basis to determine compliance, obsolescence, waste, and potential for expansion.

(3) Ensure that neither military readiness nor patient care is compromised.

(4) Will research and coordinate hardware and software installation requirements to establish, maintain and enforce this policy.

b. The 16th MEDLOG:

(1) Will establish the 121st GH Pharmacy as a direct customer and receive and issue pharmacy requested materiel to the 121st GH Pharmacy.

(2) Will stock pharmaceutical materiel that incurs six requests within a 12-month period.

Appendix A - 18th MEDCOM Policy Memorandum Number 22

EAMC-L-LO (40)
SUBJECT: Policy Memorandum Number 22, Establishment of the 16th Medical Battalion, Logistics as the Primary Source of Supply for Pharmaceutical Materiel

(3) Will utilize the Defense Logistics Agency (DLA) Prime Vendor Contracts as their primary source of supply for pharmaceutical and medical surgical materiel.

(4) Will utilize Prime Vendor Reach-Back procedures for the 121st GH Pharmacy when a monthly average of 5.5 days OST is achieved for pharmaceutical stocked materiel.

(5) Substitute materiel in kind using prime vendor equivalents unless explicitly requested by their customers not to substitute the materiel requested.

(6) Take action to effect standardization of materiel when duplicate items are identified. Provide representation to the 18th MEDCOM Standardization Committee and recommend candidates for standardization.

(7) Provide local purchase support to 18th MEDCOM units for procurement of pharmaceuticals and medical materiel.

c. All 18th MEDCOM units (minus the 121st General Hospital Pharmacy) requiring pharmaceutical and medical materiel will establish an account with the 16th MEDLOG and request all pharmaceutical and medical materiel from the 16th MEDLOG.

d. The 121st General Hospital Pharmacy:

(1) Will establish an account with the 16th MEDLOG and request pharmaceutical materiel stocked at the 16th MEDLOG.

(2) Will order all routine pharmaceuticals from the 16th MEDLOG using Prime Vendor Reach-Back procedures once the 16th MEDLOG's OST averages 5.5 days. May retain the DLA Prime Vendor Contract under the purview of the Prime Vendor Reach Back process.

Appendix A - 18th MEDCOM Policy Memorandum Number 22

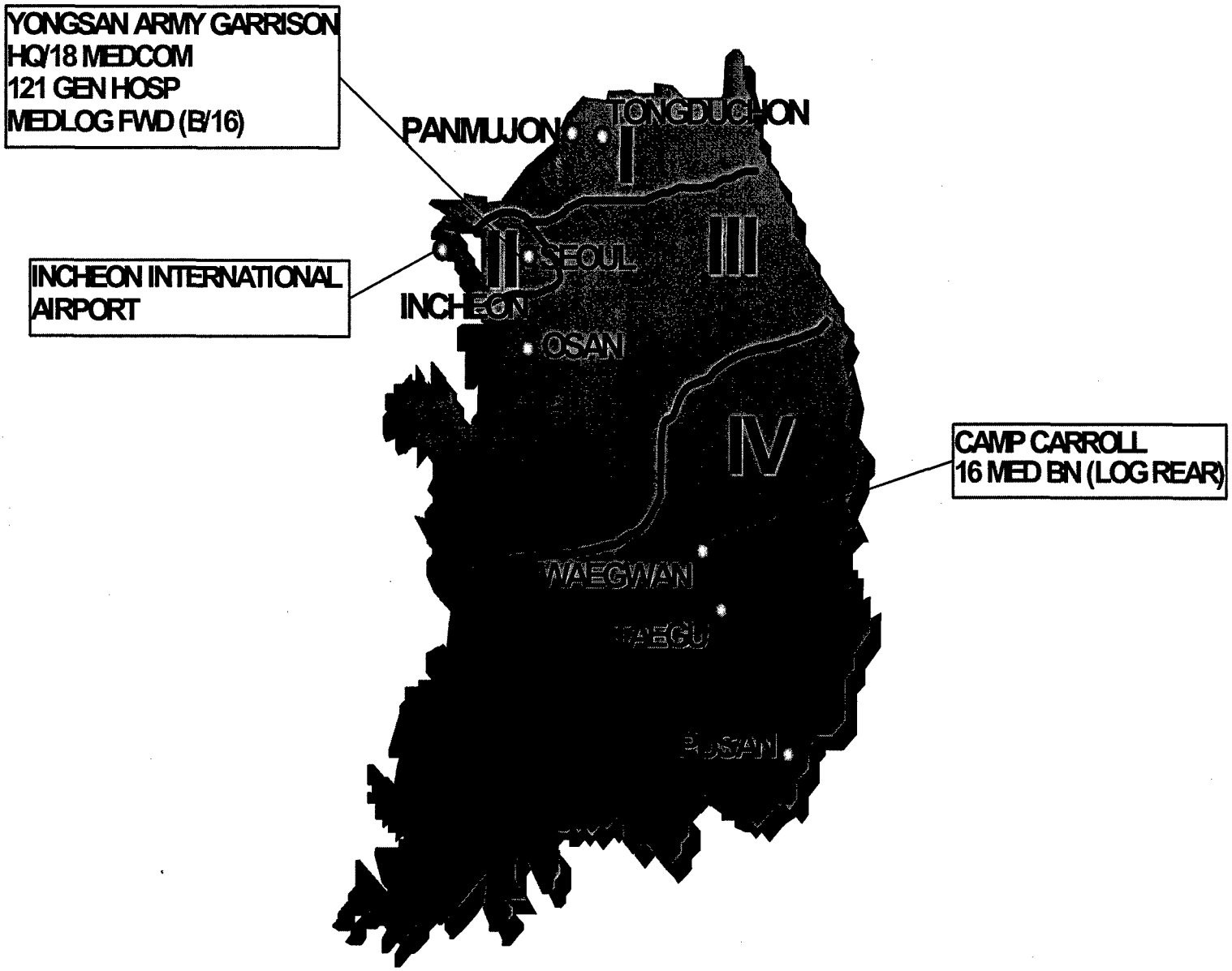
EAMC-L-LO (40)
SUBJECT: Policy Memorandum Number 22, Establishment of the 16th Medical Battalion, Logistics as the Primary Source of Supply for Pharmaceutical Materiel

7. The point of contact for this memorandum is the Chief, Logistics Operations Division, Deputy Chief of Staff for Logistics, 18th MEDCOM at 736-4079.

PHILIP VOLPE
Colonel, MC
Commanding

DISTRIBUTION:
A

Appendix B - South Korea Pharmaceutical Logistics Sites



Appendix C - Operational Definitions

Variable	Operational Definition
Dependent	
Customer wait time	Average daily time in number of days for a drug temporarily out of stock at the 121st GH pharmacy, on valid requisition, and requested by a patient, clinic, or ward.
Order ship time	Daily average number of days for pharmaceuticals from the time they are ordered from the 121st GH until the pharmacy receives the actual product.
Independent	
Demand satisfaction	Average daily percentage of requests against stocked lines that are filled by 100 percent of the total quantity demanded.
Demand accommodation	Average daily percentage of the supply activities' success at stocking the items customers are demanding and their ability to respond in changes in demand patterns.
Cost per requisition	Daily average requisition cost in dollars for pharmaceuticals.
Volume of requisitions	Average daily number of requisitions being ordered by the 121st GH Pharmacy.
Source of supply	Code 1 if a PV requisition and 0 otherwise.

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